

# MARPOL Annex VI

## Change-over procedures and calculations



■ Emission Control Areas (ECAs) – 1.00% maximum marine fuel sulphur limit from 1 July 2010

■ EU Ports – 0.1% maximum marine fuel sulphur limit for ships at berth from 1 January 2010

### Background

Reg.14(6) of MARPOL Annex VI requires that ships allow sufficient time for any fuel oil service system (heavy fuel oils, marine diesel oils and gas oils), regardless of use on board (ie. in combustion engines, boilers, gas turbines etc.), to be fully flushed of all fuels exceeding \*1.00% sulphur prior to entering an ECA.

Documentation of such change-over procedures is currently not needed, but may be implemented through the ISM code in the not too distant future. Further, documented procedures will be an advantage to crew during operation and they provide credibility in connection with statutory and third-party enforcement.

For ships continuously operating on low sulphur fuel oil (LSFO) and those that in the future will be equipped with exhaust cleaning systems (Exhaust Scrubbers), change-over is not an issue.

For ships provided with redundant service and settling tanks, it is also a minor challenge, as the change-over time is related to the dilution of existing high sulphur fuel oil (HSFO) in the fuel oil service system only.

However, the majority of shipowners appear to prefer the strategy of changing from high sulphur to LSFO prior to ECA entry.

Most ships, both old and new, are equipped with single service tanks only. For such vessels, efficient change-over may represent a considerable challenge. Needless to say, the longer the change-over time, the greater the cost in terms of high cost LSFO.

DNVPS can help owners review their newbuilding or dry-docking specifications and associated system P&IDs in order to enhance and simplify the change-

Operation in Sox Emission Control Areas (ECAs) introduces new challenges to ship operators, both with respect to bunker management and voyage planning. DNV Petroleum Services (DNVPS) can assist owners in developing and endorsing change-over calculations for their ships and thus demonstrate compliance with regulation 14 of MARPOL Annex VI.

over, save costs and ensure compliance. Please note that modifications to fuel systems are also subject to Class approval.

*\*1.50% maximum fuel sulphur limit applicable prior to 1 July 2010, down to 0.10% from 1 January 2015 onwards.*

### Change-over parameters

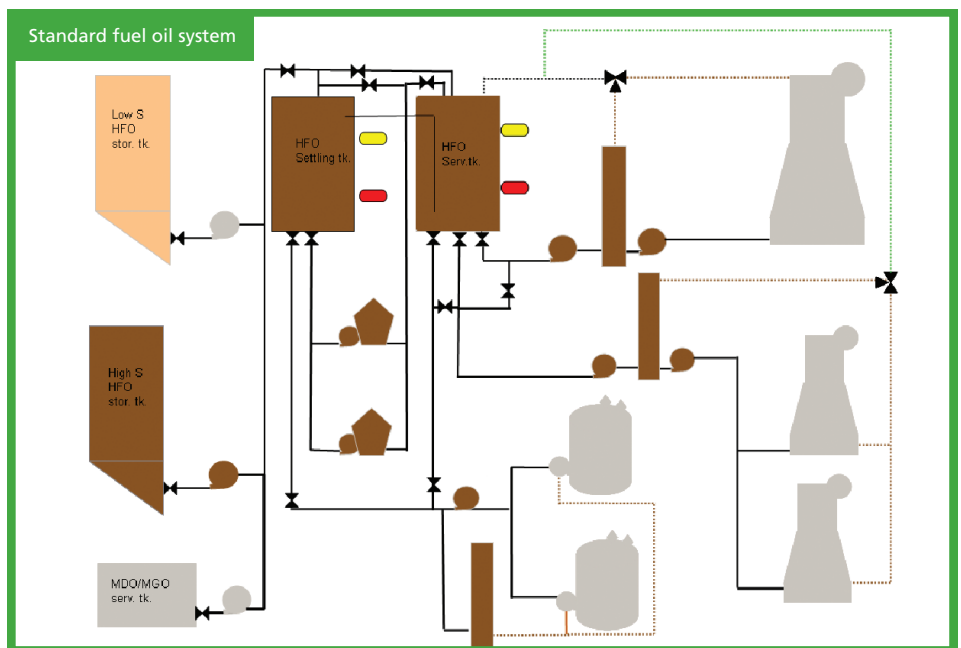
There are a number of different strategies that can be selected. We will consider those that refer to a standard fuel oil system configuration, as indicated in the following diagram. This involves the standard change-over based on existing practices used.

### Total fuel consumption rate:

The higher the consumption, the lower the change-over time will be. The complexity is related to selecting the appropriate consumption in the period the change-over takes place (could involve port stay where main engine consumption is negligible but auxiliary engine and boiler consumption is high). In some cases, boilers are fed by the settling tank, and this contributes only to draining of the settling tank and not to the direct reduction of the service tank sulphur level.

### Total volume in the fuel oil system:

The larger the total volume in the settling tank



### Sulphur content:

The higher the initial sulphur level, the longer the change-over time will be. As well, the higher the LSFO sulphur level, the longer the change-over time. The worst case is \*\*0.99%, which is often the default sulphur level on the Bunker Delivery Note. It is important to know the exact sulphur content of the delivered product by testing the bunker sample. Using the actual sulphur value will help you determine accurate timings for your change-over procedure.

*\*\* Based on the scenario of 1.00% maximum fuel sulphur limit*

and associated piping to be blended (diluted), the longer the change-over time. Ideally, the settling tank should be drained completely.

The larger the total volume in the service tank and associated piping to be blended (diluted), the longer the change-over time. Ideally, the service tank should be drained to a minimum safe level (eg. 25%), also as a contingency to reduce compatibility problems.

### Separator(s) capacity:

If the service tank is dropped to 25% level, then the separator capacity is often increased until the service tank is full (remembering to take into consideration the water, cat fines, and sediment levels in the LSFO to be treated). However, when the service tank is full, it is recommended that as far as practicable, the separator capacity is set equivalent to the total consumption. One reason is that a constant backflow to the service tank will re-circulate fuel and increase the sulphur level in the settling tank and subsequently the service tank. This effect will be particularly evident when the LSFO sulphur level approaches the target of 1.00% maximum limit.

### Fuel transfer pump(s) capacity:

Provided the piping arrangement facilitates stripping of the service tank, the transfer pump capacity will affect the time needed to drain it. Similarly, the pump capacity will have impact on the time needed to charge the settling tank after stripping.

### Change-over recording

Details of fuel oil change-over procedures from HSFO to LSFO, and vice versa, need to be recorded upon completion of the change-over, as follows:

- The volume of LSFO in each tank onboard
- Date, time and the position of the ship

DNV Petroleum Services considers the engine room log book to be most suited for such recordings.

### DNVPS change-over procedures

DNVPS can assist in developing ship-specific change-over procedures. The inputs required are given in Diagrams 1 and 2 and reflect the strategy specified by the owner. Vital points to note include the selection of total consumption to be used during change-over, as well as the separator feed rate. Of equal importance is the level of fuel oil in the service and settling tanks upon the start of the change-over.

Once such information is submitted, DNVPS will develop a tailor-made change-over procedure report for the ship, which includes calculation of change-over times. The change-over times will be given as a function of HSFO and LSFO levels, presented in Diagrams 3 and 4.

For more information, please contact your DNVPS Customer Service Manager or the nearest DNVPS regional office.

DIAGRAM 1

| Fixed input parameters (for a ship)                           |                    |
|---|--------------------|
| Settling Tank HIGH fill volume (when transfer is stopped)     | m <sup>3</sup>     |
| Settling Tank LOW fill volume (when transfer is initiated)    | m <sup>3</sup>     |
| Service Tank maximum level (level= Overflow to Settling Tank) | m <sup>3</sup>     |
| Fuel transfer pump capacity (during filling)                  | m <sup>3</sup> /hr |
| Fuel piping system volume (after Service Tank)                | m <sup>3</sup>     |
| Transfer piping system volume (before Settling Tank)          | m <sup>3</sup>     |

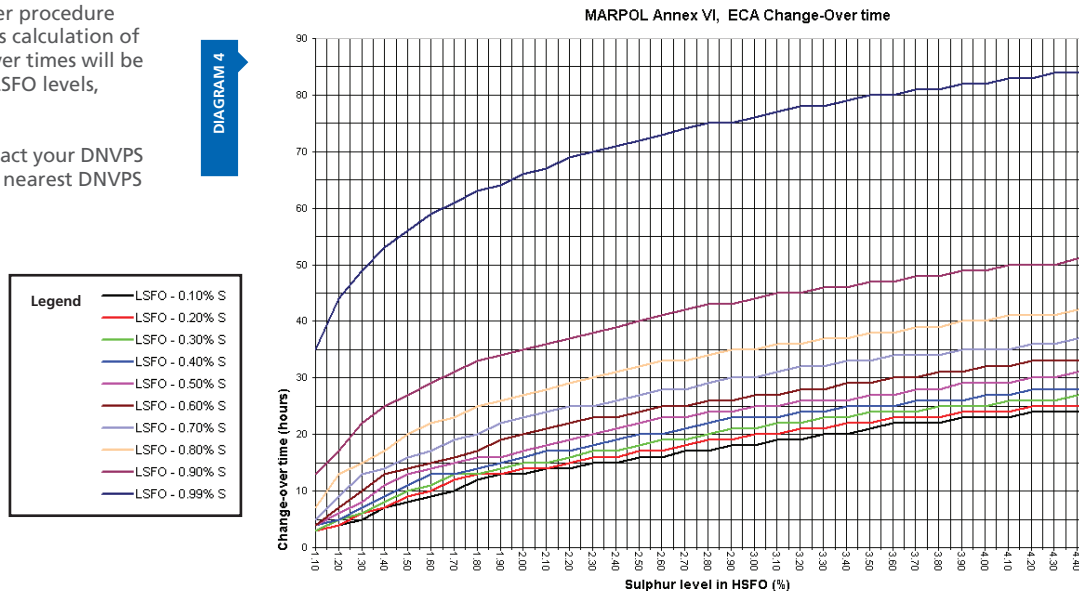
DIAGRAM 2

| Variable input parameters                                       |                    |
|---|--------------------|
| Settling Tank volume (when change-over starts)                  | m <sup>3</sup>     |
| Service Tank volume (when change-over starts)                   | m <sup>3</sup>     |
| Separator feed rate (during change-over)                        | m <sup>3</sup> /hr |
| Total Engine consumption from Service Tank (during change-over) | m <sup>3</sup> /hr |
| Boiler consumption from Settling Tank (during change-over)      | m <sup>3</sup> /hr |
| Boiler consumption from Service Tank (during change-over)       | m <sup>3</sup> /hr |

DIAGRAM 3

| HSFO % | Change-over times for various Sulphur combinations (Hrs) |      |      |      |      |      |      |      |      |      |
|--------|--|------|------|------|------|------|------|------|------|------|
|        | LSFO %   |      |      |      |      |      |      |      |      |      |
|        | 0.10   | 0.20 | 0.30 | 0.40 | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 0.99 |
| 1.10   | 3  | 3    | 3    | 4    | 4    | 4    | 5    | 7    | 13   | 35   |
| 1.20   | 4  | 4    | 5    | 5    | 6    | 7    | 9    | 13   | 17   | 44   |
| 1.30   | 5  | 6    | 6    | 7    | 8    | 10   | 13   | 15   | 22   | 49   |
| 1.40   | 7  | 7    | 8    | 9    | 11   | 13   | 14   | 17   | 25   | 53   |
| 1.50   | 8  | 9    | 10   | 11   | 13   | 14   | 16   | 20   | 27   | 56   |
| 1.60   | 9  | 10   | 11   | 13   | 14   | 15   | 17   | 22   | 29   | 59   |
| 1.70   | 10   | 12   | 13   | 13   | 15   | 16   | 19   | 23   | 31   | 61   |
| 1.80   | 12   | 13   | 13   | 14   | 16   | 17   | 20   | 25   | 33   | 63   |
| 1.90   | 13   | 13   | 14   | 15   | 16   | 19   | 22   | 26   | 34   | 64   |
| 2.00   | 13   | 14   | 15   | 16   | 17   | 20   | 23   | 27   | 35   | 66   |
| 2.10   | 14   | 14   | 15   | 17   | 18   | 21   | 24   | 28   | 36   | 67   |
| 2.20   | 14   | 15   | 16   | 17   | 19   | 22   | 25   | 29   | 37   | 69   |
| 2.30   | 15   | 16   | 17   | 18   | 20   | 23   | 25   | 30   | 38   | 70   |
| 2.40   | 15   | 16   | 17   | 19   | 21   | 23   | 26   | 31   | 39   | 71   |
| 2.50   | 16   | 17   | 18   | 20   | 22   | 24   | 27   | 32   | 40   | 72   |
| 2.60   | 16   | 17   | 19   | 20   | 23   | 25   | 28   | 33   | 41   | 73   |
| 2.70   | 17   | 18   | 19   | 21   | 23   | 25   | 28   | 33   | 42   | 74   |
| 2.80   | 17   | 19   | 20   | 22   | 24   | 26   | 29   | 34   | 43   | 75   |
| 2.90   | 18   | 19   | 21   | 23   | 24   | 26   | 30   | 35   | 43   | 75   |
| 3.00   | 18   | 20   | 21   | 23   | 25   | 27   | 30   | 35   | 44   | 76   |
| 3.10   | 19   | 20   | 22   | 23   | 25   | 27   | 31   | 36   | 45   | 77   |
| 3.20   | 19   | 21   | 22   | 24   | 26   | 28   | 32   | 36   | 45   | 78   |
| 3.30   | 20   | 21   | 23   | 24   | 26   | 28   | 32   | 37   | 46   | 78   |
| 3.40   | 20   | 22   | 23   | 25   | 26   | 29   | 33   | 37   | 46   | 79   |
| 3.50   | 21   | 22   | 24   | 25   | 27   | 29   | 33   | 38   | 47   | 80   |
| 3.60   | 22   | 23   | 24   | 25   | 27   | 30   | 34   | 38   | 47   | 80   |
| 3.70   | 22   | 23   | 24   | 26   | 28   | 30   | 34   | 39   | 48   | 81   |
| 3.80   | 22   | 23   | 25   | 26   | 28   | 31   | 34   | 39   | 48   | 81   |
| 3.90   | 23   | 24   | 25   | 26   | 29   | 31   | 35   | 40   | 49   | 82   |
| 4.00   | 23   | 24   | 25   | 27   | 29   | 32   | 35   | 40   | 49   | 82   |
| 4.10   | 23   | 24   | 26   | 27   | 29   | 32   | 35   | 41   | 50   | 83   |
| 4.20   | 24   | 25   | 26   | 28   | 30   | 33   | 36   | 41   | 50   | 83   |
| 4.30   | 24   | 25   | 26   | 28   | 30   | 33   | 36   | 41   | 50   | 84   |
| 4.40   | 24   | 25   | 27   | 28   | 31   | 33   | 37   | 42   | 51   | 84   |
| 4.50   | 24   | 25   | 27   | 29   | 31   | 34   | 37   | 42   | 51   | 85   |

DIAGRAM 4



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